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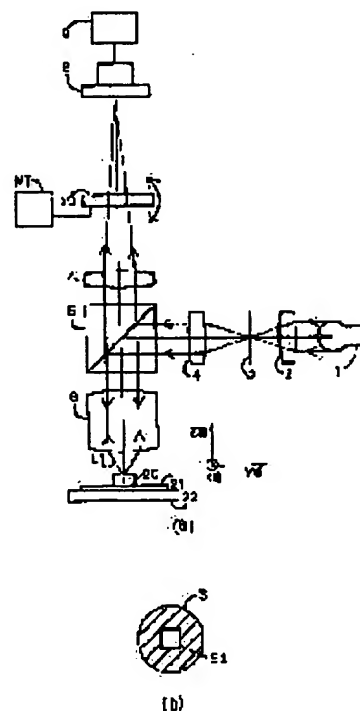
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(54) REGISTRATION MEASURING DEVICE, AND MANUFACTURE OF SEMICONDUCTOR DEVICE USING THE DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a device, which can adjust the misregistration of a mark caused by color (wavelength), according to the color dispersion property of an image pickup optical system, and can accurately measure the registration.

SOLUTION: In a registration measuring device which has illumination optical systems 1-5 for illuminating the board having a first mark and a second mark at least, image pickup optical systems 6-7 for forming the image of each mark, an image pickup part for detecting the image of each mark, and a processor 9 for obtaining the quantity of misregistration between the first mark and the second mark, based on the output signal from the image pickup device, the image pickup optical system includes an adjuster 10 for adjusting the dislocation of the image of each mark caused by the color occurring at the image pickup face of the image pickup part, based on the prescribed information.



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CLAIMS

[Claim(s)]

[Claim 1] The illumination-light study system for illuminating the substrate which has the 1st mark and 2nd mark at least, The image formation optical system for forming the image of each of said mark, and the image pick-up section for detecting said each mark image, In the superposition measuring device which has the data-processing section for calculating the amount of superposition gaps of said 1st mark and said 2nd mark based on the output signal from said image pick-up section Said image formation optical system is a superposition measuring device characterized by including the controller which adjusts a gap of said each mark image by the color in the image pick-up side of said image pick-up section based on predetermined information.

[Claim 2] In order to adjust a gap of said mark image generated according to each down stream processing given to said substrate The storage section which memorizes the adjustment value of a gap of said mark image for said every down stream processing is arranged. Said controller The superposition measuring device characterized by adjusting a gap of said mark image optically as said predetermined information based on the adjustment value of a gap of said mark image for said every down stream processing memorized in said storage section.

[Claim 3] The process which calculates the amount of gaps of said 1st mark and said 2nd mark using a superposition measuring device according to claim 1 or 2, The process which calculates the offset value for performing relative alignment of the mask which has a predetermined pattern, and said substrate based on said amount of gaps, The semiconductor device manufacture approach characterized by including the process which performs relative alignment of said mask and said substrate based on said offset value, and the process which exposes the pattern of said mask to said substrate.

[Claim 4] The semiconductor device manufacture approach characterized by to include the process which adjusts a gap of the image-formation location by the color of said mark for alignment produced by the process which detects the mark for alignment formed in the substrate by location detection optical system, and the optical property of said location detection optical system, the process which perform the alignment of said substrate, and the process which expose the pattern of said mask to said substrate through projection optics.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Field of the Invention] This invention is suitable, when it carries out projection exposure of the semiconductor device manufacture approach equipped with superposition equipment and this equipment, and the electronic-circuitry pattern currently especially formed on the mask side according to projection optics in a wafer side, and observing the condition on a wafer side, performing relative alignment of a mask and a wafer by this and manufacturing the semiconductor device of a high degree of integration.

[0002]

[Description of the Prior Art] In the photolithography process for manufacturing a semiconductor device, projection exposure of the circuit pattern formed in the mask is carried out on a wafer according to projection optics. At this time, by observing a wafer side using observation equipment in advance of projection exposure, the mark for alignment on a wafer is detected and relative alignment of a mask and a wafer and the so-called alignment are performed based on this detection result. Alignment is performed by measuring the amount of superposition gaps of the resist pattern and substrate pattern which were formed in the projection exposure process using the superposition measuring device. A superposition measuring device irradiates the illumination light to the mark for superposition (alignment), carries out image formation of the reflected light from this mark to a predetermined side through image formation optical system, picturizes this mark image with a CCD camera etc., performs an image processing, and measures the amount of superposition gaps.

[0003]

[Problem(s) to be Solved by the Invention] However, when the reflected light from the mark for superposition has the large wavelength spectrum, an image formation location shifts under the effect of the chromatism property of an image formation optical-system proper, and it is set to one of the causes which produce the measurement error value of an equipment proper, and the so-called TIS value (Tool Induced Shift). Moreover, depending on the class of photolithography process, the wavelength spectrums of the reflected light from a superposition mark may differ between each shot (exposure field) in the same wafer. For this reason, a TIS value may vary also within the same wafer. In this case, the dependability of the amount of gaps of the superposition of the mask and wafer which are fed back to a projection aligner becomes low, and there is a problem that the yield falls without piling up correctly and being able to expose.

[0004] This invention is made in view of the above-mentioned problem, can adjust a gap of the superposition mark generated by the color (wavelength) according to the chromatism property of image formation optical system, and aims at offering the semiconductor device manufacture approach which can carry out alignment of a mask and the wafer correctly using the equipment which can measure superposition correctly, and this equipment.

[0005]

[Means for Solving the Problem] An illumination-light study system for this invention to illuminate the substrate which has the 1st mark and 2nd mark at least, in order to solve the above-mentioned technical problem, The image formation optical system for forming the image of each of said mark, and the image pick-up section for detecting said each mark image, In the superposition measuring device which has the data-processing section for calculating the amount of superposition gaps of said 1st mark and said 2nd mark based on the output signal from said image pick-up section The superposition measuring device characterized by said image formation optical system containing the controller which adjusts a gap of said each mark image by the

color in the image pick-up side of said image pick-up section based on predetermined information is offered.

[0006] Moreover, in order to adjust a gap of said mark image generated in the desirable mode of this invention according to each down stream processing given to said substrate The storage section which memorizes the adjustment value of a gap of said mark image for said every down stream processing is arranged, and, as for said controller, it is desirable as said predetermined information to adjust a gap of said mark image optically based on the adjustment value of a gap of said mark image for said every down stream processing memorized in said storage section.

[0007] Moreover, the process which this invention asks for the amount of gaps of said 1st mark and said 2nd mark using a superposition measuring device according to claim 1 or 2, The process which calculates the offset value for performing relative alignment of the mask which has a predetermined pattern, and said substrate based on said amount of gaps, The semiconductor device manufacture approach characterized by including the process which performs relative alignment of said mask and said substrate based on said offset value, and the process which exposes the pattern of said mask to said substrate is offered.

[0008] Moreover, the semiconductor device manufacture approach characterized by for this invention to include the process which adjusts a gap of the image-formation location by the color of said mark for alignment which produces by the process which detects the mark for alignment formed in the substrate by location detection optical system, and the optical property of said location detection optical system, the process which perform the alignment of said substrate, and the process which expose the pattern image of said mask to said substrate through projection optics offers.

[0009]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on an accompanying drawing.

(The 1st operation gestalt) Drawing 1 (a) is drawing showing the outline configuration of the superposition measuring device concerning the 1st operation gestalt. It is condensed by the condenser lens 2 and the illumination-light bundle injected from the light source 1 illuminates a field diaphragm 3 to homogeneity. A field diaphragm 3 has the rectangle opening S1, as shown in drawing 1 (b). Next, the flux of light which passed the field diaphragm 3 is changed into the abbreviation parallel flux of light by the lighting relay lens 4 (collimated), and is reflected by the half prism 5. And it is condensed with the 1st objective lens 6, and the wafer 21 which has the superposition mark 20 is irradiated perpendicularly. Here, since a field diaphragm 3 and a wafer 21 are in a location [****], the field on the wafer 21 according to the configuration of the opening S1 of diaphragm 3 is illuminated by homogeneity. Moreover, the wafer 21 is laid on the stage 22 which has a rolling mechanism, and a setup of the measurement direction can be changed by rotating a stage centering on an optical axis AX.

[0010] The reflected light L1 from the superposition mark 20 on the illuminated wafer is collimated by the 1st objective lens 6, penetrates the half prism 5, and it is again condensed with the 2nd objective lens 7, and it penetrates the plane-parallel plate 10 which has a chromatism adjustment function. And the flux of light L1 carries out image formation of the image of the superposition mark 20 on an image sensor CCD 8. Drawing 2 (a) and (b) are drawings showing the configuration of the superposition (resist) mark 20. A processing unit 9 performs image processings, such as edge detection, and computes the difference R of the mark center position C1 of the superposition mark 20, and the Mark Shimoji center position C2 as an amount of superposition gaps. It is desirable for the shot fields S1-S5 to measure 2 times of the amounts of superposition gaps preferably, in the direction (drawing 4) which rotated the wafer 21 for the marks M1-M5 which it has respectively 180 degrees to the predetermined direction (drawing 3) and this predetermined direction, as shown in drawing 3 and drawing 4 . And when the measurement result in the direction which rotated the measurement result in the predetermined direction 180 degrees to R0 and this direction is set to R180, respectively, the TIS value of the amount of measurement gaps which this equipment has is calculated by the degree type.

[0011] $TIS = (R0 + R180) / 2$ -- here, as one of the causes which TIS produces, as mentioned above, gap of the image formation location of the whole mark image by the difference in the color (wavelength) of the reflected light from the superposition mark 20 can be considered. Drawing 5 shows the image formation location IB of blue glow and the image formation location IR of red light when not having the chromatism property with the unsymmetrical image formation optical system which consists of the 1st objective lens 6, the half prism 5, and the 2nd objective lens 7 for carrying out image formation of the mark 21 on CCD, respectively. As shown in

drawing, image formation of IB and the IR is carried out to the symmetric position to the shaft L passing through the visual field core C, respectively. On the other hand, if image formation optical system has the chromatism property, as shown in drawing 6, the image formation location IB of blue glow and the image formation location IR of red light will become unsymmetrical to Shaft L. For this reason, the measured value of the amount of superposition gaps by the above-mentioned procedure will include the TIS value of a measuring device proper. The prism effectiveness by the optical element which constitutes image formation optical system carrying out eccentricity as a cause which produces an unsymmetrical chromatism property is mentioned. Moreover, the amount of chromatism which image formation optical system has also has a solid-state difference for every equipment.

[0012] Next, the function of a plane-parallel plate 10 to adjust gap of the mark image formation location by the difference in an above-mentioned color is explained. As shown in drawing 7, the flux of light LB (continuous line) from which wavelength differs among the reflected lights from the mark which has advanced the same optical path toward the image pick-up side (image formation side) S of CCD8, for example, blue glow, and the red light LR (broken line) are considered. two -- the flux of light -- LB -- LR -- a plane-parallel plate -- ten -- penetrating -- a case -- drawing 8 -- being shown -- as -- a plane-parallel plate -- ten -- an optical axis -- AX -- receiving -- an include angle -- theta -- only -- inclining -- **** -- if -- prism -- effectiveness -- the flux of light - LB -- LR -- differing -- an optical path -- a passage -- the image surface S -- differing -- a location -- image formation -- carrying out . This is the same also about flux of light LB' besides an optical axis, and LR'. Thus, the image formation location of the mark image on CCD changes with wavelength of the reflected light. The difference delta of the image formation location of LB and LR can be adjusted by changing the tilt angle theta of a plane-parallel plate 10 by Motor MT (drawing 1). Therefore, a gap of the image formation location by the color can be amended by adjusting whenever [angle-of-inclination / of a plane-parallel plate 10].

[0013] (The 2nd operation gestalt) Drawing 9 is drawing showing roughly the projection aligner whole configuration equipped with the above-mentioned superposition measuring device. In the projection aligner of illustration, the light injected from the light source 31 illuminates to homogeneity the mask 33 with which the predetermined pattern was formed through the illumination-light study system 32.

[0014] In addition, one or more bending mirrors for deflecting an optical path from the light source 31 to the optical path to the illumination-light study system 32 if needed are arranged. Moreover, when the light source 31 and the body of a projection aligner are another objects, optical system, such as an automatic tracking unit which always turns the sense of the light from the light source 31 to the body of a projection aligner, and plastic surgery optical system for operating the flux of light cross-section configuration of the light from the light source 31 orthopedically in predetermined size and configuration, a quantity of light controller, is arranged. Moreover, the illumination-light study system 32 has optical system, such as field-diaphragm image formation optical system which projects the field diaphragm for specifying the size and the configuration of the lighting field for example, on the optical integrator which consists of a fly eye lens or an internal reflection mold integrator, and forms the surface light source of a predetermined size and configuration, and a mask 33, and the image of this field diaphragm to up to a mask. The optical path between the light source 31 and the illumination-light study system 32 is sealed by casing (un-illustrating). Most in the illumination-light study system 32 from the light source 31 furthermore, the space to the optical member by the side of a mask The mask 33 permuted with the inert gas which is gases with the low rate of the exposure absorption of light, such as gaseous helium and nitrogen, is held in parallel with XY flat surface on the mask stage 35 through the mask holder 34. The pattern space of the shape of a rectangle which the pattern which should be imprinted is formed in the mask 33, and has a long side along the direction of Y among the whole pattern space, and has a shorter side along the direction of X (the shape of a slit) is illuminated. It is constituted so that a mask stage 35 may be measured by operation of the drive system which omitted illustration with the interferometer 37 with which it is movable two-dimensional along a mask side (namely, XY flat surface) with the interferometer, and the position coordinate used the mask migration mirror 36 and position control may be carried out.

[0015] The light from the pattern formed in the mask 33 forms a mask pattern image through projection optics 38 on the wafer 39 which is a photosensitive substrate. The wafer 39 is held in parallel with XY flat surface on the wafer stage 41 through the wafer holder 40. And on a wafer 39, a pattern image is formed in the exposure field of the shape of a rectangle which has a long side along the direction of Y, and has a shorter side along the direction of X so that it may correspond to the lighting field of the shape of a rectangle on a mask 33 optically.

[0016] The wafer stage 41 is constituted so that it may be measured by the interferometer 43 for which it is movable two-dimensional and the position coordinate used the wafer migration mirror 42 along the wafer side (namely, XY flat surface) according to an operation of the drive system which omitted illustration and position control may be carried out.

[0017] Moreover, it consists of projection aligners of illustration so that the interior of projection optics 38 may maintain an airtight condition between the optical member most arranged at the mask side among the optical members which constitute projection optics 38, and the optical member arranged most at the wafer side, and the gas inside projection optics 38 is permuted by inert gas, such as gaseous helium and nitrogen.

[0018] Furthermore, although the mask 33, the mask stage 35, etc. are arranged at the narrow optical path between the illumination-light study system 32 and projection optics 38, the interior of casing (un-illustrating) which carries out seal envelopment of a mask 33, the mask stage 35, etc. is filled up with inert gas, such as nitrogen and gaseous helium.

[0019] Moreover, although the wafer 39, the wafer stage 41, etc. are arranged at the narrow optical path between projection optics 38 and a wafer 39, the interior of casing (un-illustrating) which carries out seal envelopment of a wafer 39, the wafer stage 41, etc. is filled up with inert gas, such as nitrogen and gaseous helium. Thus, the whole optical path from the light source 31 to a wafer 39 is covered, and the ambient atmosphere by which exposure light is hardly absorbed is formed.

[0020] As mentioned above, the visual field field on the mask 33 specified according to projection optics 38 (lighting field) and the projection field on a wafer 39 (exposure field) have the shape of a rectangle which has a shorter side along the direction of X. Therefore, performing position control of a mask 33 and a wafer 39 using a drive system, an interferometer (37 43), etc. It meets in the direction of a shorter side of X, i.e., direction, of a rectangle-like exposure field and a lighting field. A mask stage 35 and the wafer stage 41 as a result, by moving a mask 33 and a wafer 39 synchronous (scan) Scan exposure of the mask pattern is carried out to the field which has width of face equal to the long side of an exposure field on a wafer 39, and has the die length according to the amount of scans of a wafer 39 (movement magnitude).

[0021] Moreover, the optical system AL for alignment for performing relative alignment of a mask 33 and a wafer 39 is established near the projection optics 38. Since the configuration of the alignment optical system AL is the same as the configuration of the superposition measuring device stated with the above-mentioned 1st operation gestalt almost, explanation is omitted.

[0022] In case projection exposure of the pattern formed on the mask 33 using the above-mentioned projection aligner is carried out at a wafer 39, it exchanges for other masks which have the pattern which changes a mask with non-illustrated mask transport devices, and a different pattern one by one on a wafer is piled up and exposed. For this reason, according to the alignment optical system AL, the amount of superposition gaps of the substrate pattern formed of the 1st exposure and the resist pattern (superposition mark) by the 2nd exposure is computed, and the offset value for alignment is calculated. And after performing relative alignment of a mask 33 and a wafer 39 by moving on a mask stage 35, the wafer stage 41, etc. based on this offset value, the pattern of a mask 33 is exposed on a wafer 39 through projection optics 38.

[0023] Next, the adjustment procedure of the plane-parallel plate 10 within the alignment optical system AL in this projection aligner is described. When it originates in the difference of the thickness of each mark etc. when the superposition marks M1-M5 from which a shot field differs within the same wafer exist, as shown in drawing 3, and the spectrums of the reflected light differ for every mark, whenever [effect / of the TIS value on each marks M1-M5] may change with chromatism properties of image formation optical system. Therefore, in a certain kind of lithography process, the TIS values of each mark may differ greatly in the same wafer.

[0024] In this case, it is desirable to ask for theta beforehand whenever [angle-of-inclination / of a plane-parallel plate 10] so that a TIS value may be measured for every shot field and that variation (distribution sigma) may serve as min using the sample wafer with which color information (image formation location of the mark by the color) differs for every shot field in a wafer. For example, drawing 10 (a) is drawing of a characteristic curve showing the relation between theta (axis of abscissa) and Variance sigma (axis of ordinate) whenever [in a certain down stream processing / angle-of-inclination]. The distribution sigma of a TIS value serves as min at an include angle theta 0. On the other hand, the characteristic curve of the relation between theta and the TIS variance sigma is shown in drawing 10 (b) whenever [in other down stream processing of the same sample wafer / angle-of-inclination]. The form of a characteristic curve changes with the difference in

down stream processing, for example, the 1st exposure process, and 2nd exposure processes so that clearly from drawing 10 (a) and (b). For this reason, when measuring θ_0 as an adjustment value beforehand whenever [angle-of-inclination / from which a TIS variance serves as min for every down stream processing using a sample wafer], memorizing in Memory M (drawing 9) and measuring an actual **ed wafer, a gap of a mark image is optically adjusted by leaning the parallel plate 10 by Motor MT so that it may become the optimum value θ_0 of whenever [angle-of-inclination / which was memorized for every down stream processing]. This procedure can adjust easily an image formation location gap of the mark image by the color.

[0025] Moreover, with this operation gestalt, although the include angle of a plane-parallel plate 10 is changed for every down stream processing, when it desires shortening of the measuring time, or when the optimum value θ_0 of whenever [angle-of-inclination] is abbreviation regularity in two or more down stream processing, two or more down stream processing in the condition of having set the plane-parallel plate 10 as one include angle θ_0 may be performed.

[0026] Moreover, this invention is not restricted to what was indicated to the claim, but can also take the following configurations.

(A) The illumination-light study system for illuminating the substrate which has the 1st mark and 2nd mark at least, The image formation optical system for forming the image of each of said mark, and the image pick-up section for detecting said each mark image, In the alignment equipment which has the data-processing section for calculating the amount of superposition gaps of said 1st mark and said 2nd mark based on the output signal from said image pick-up section Said image formation optical system is alignment equipment characterized by including the controller which adjusts a gap of said each mark image by the color in the image pick-up side of said image pick-up section based on predetermined information.

[0027] (B) The illumination-light study system for illuminating the mask with which the predetermined pattern was formed, The alignment equipment of the above-mentioned (A) publication which detects the mark for alignment formed in the substrate, The projection aligner characterized by having a mechanical component for performing relative alignment of said substrate and said mask based on the amount of superposition gaps obtained with said alignment equipment, and the projection optics for carrying out projection exposure of the pattern of said mask at said substrate.

[0028] Thus, this invention can take various gestalten.

[0029]

[Effect of the Invention] As explained above, according to the superposition measuring device concerning this invention, the amount of chromatism which optical system has can be adjusted to the optimal value, and image formation location gap of the whole mark image resulting from the difference in the wavelength of the reflected light from a superposition mark can be prevented. This reduces generating of the measurement error of an equipment proper, and measurement of the highly precise amount of superposition gaps can be performed. Moreover, according to the semiconductor device manufacture approach of this invention, a mask and a wafer are piled up correctly relatively, and since projection exposure can be carried out, the yield at the time of manufacture of a device component can be raised.

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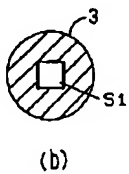
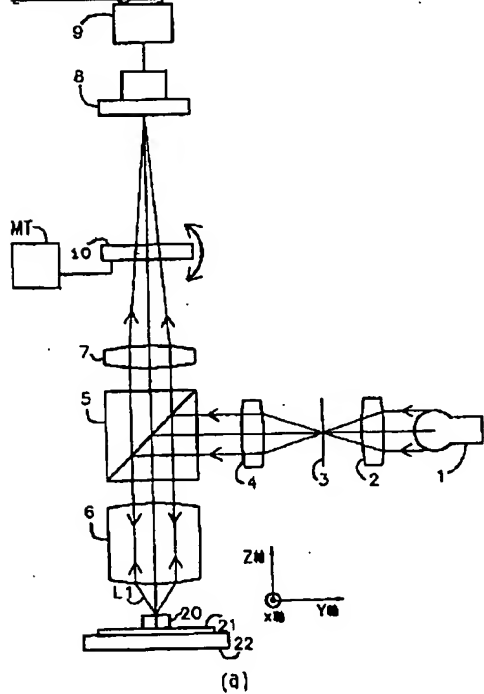
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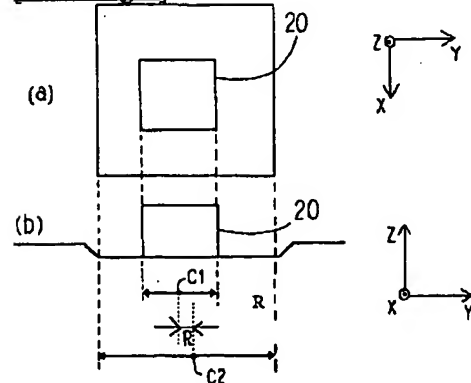
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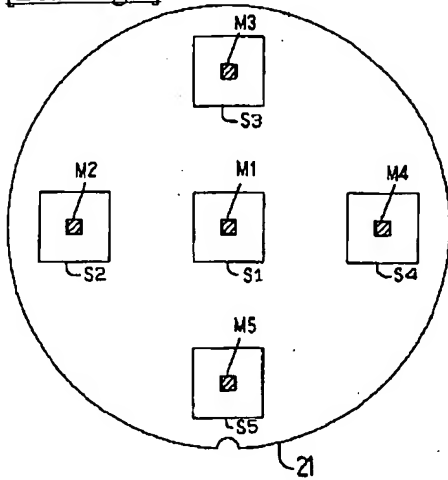
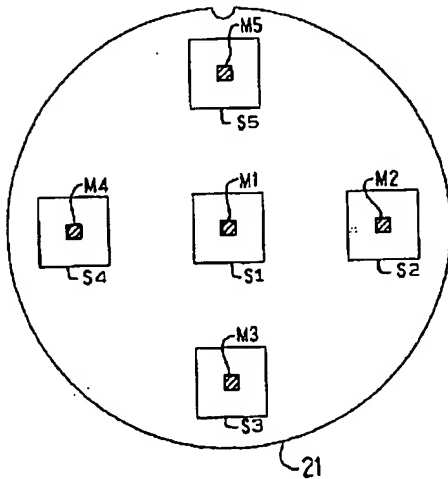
DRAWINGS

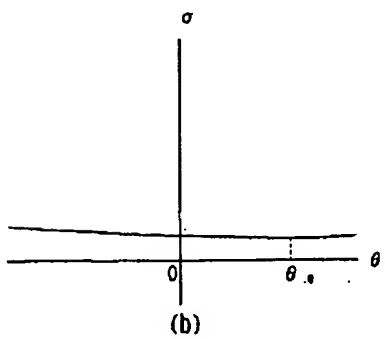
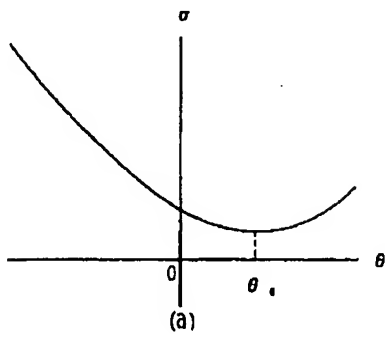
[Drawing 1]



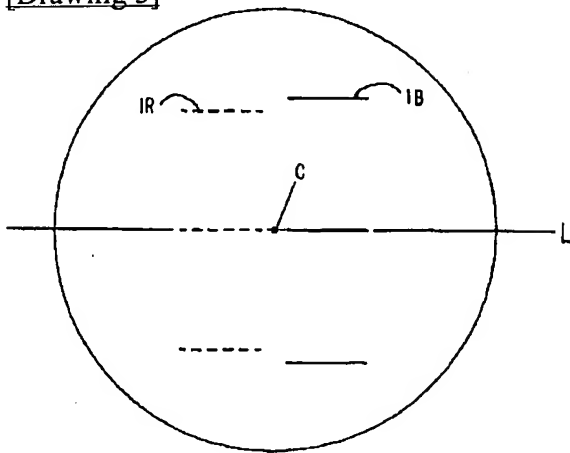
[Drawing 2]



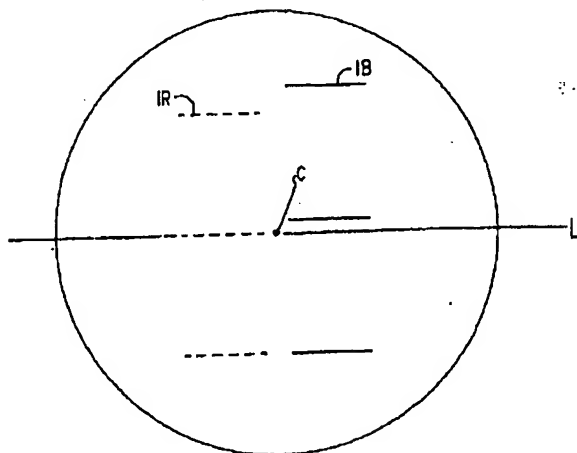
[Drawing 3][Drawing 4][Drawing 10]



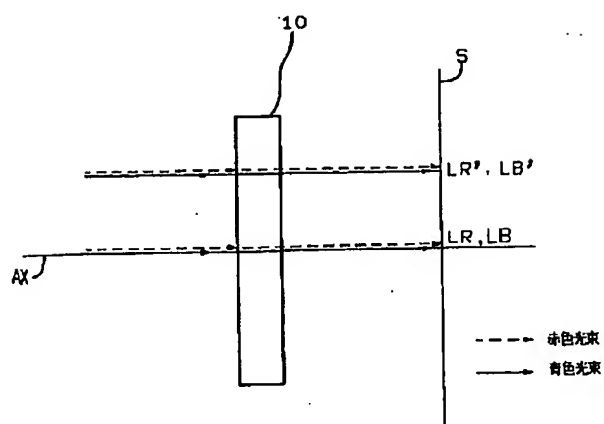
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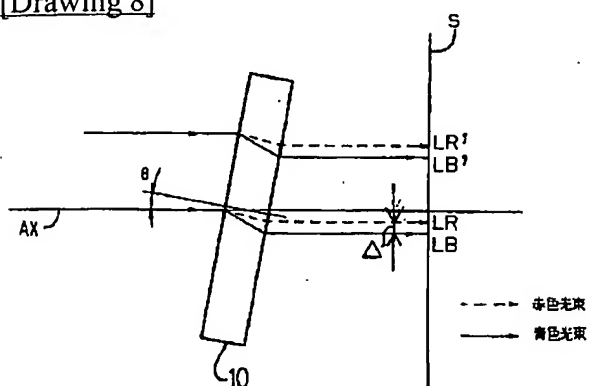
[Drawing 6]



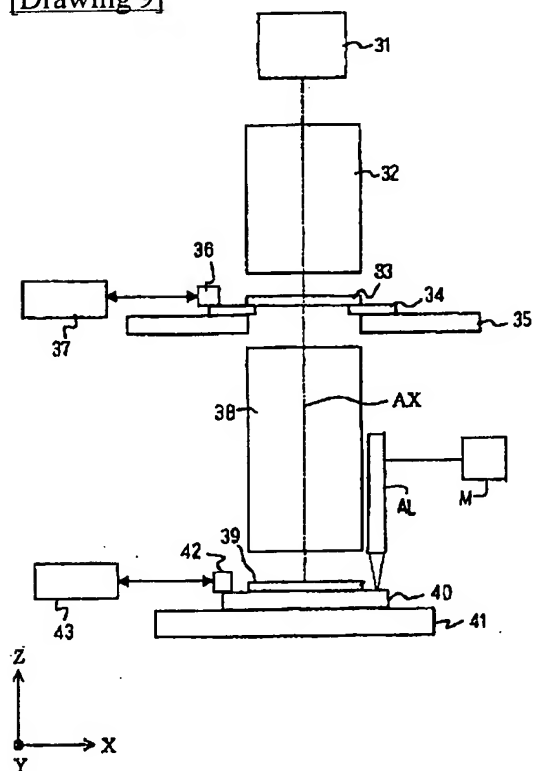
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]